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(54) A MICROELECTRONIC POSITION SENSOR

MIKROELEKTRONISCHER POSITIONSSENSOR

CAPTEUR DE POSITION MICROELECTRONIQUE

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Description

The invention relates to a microelectronic position sensor, e.g for use in hearing aids and the like for volume control, function shifts or changes of another adjustable parameter of the apparatus, said position sensor operating by means of magnetic field sensitive elements and comprising a stationary base portion or stator which contains magnetic field sensitive elements and an adjustment means or rotor which is rotatably mounted and contains a permanent magnet, and wherein the stator is electrically coupled to the apparatus by means of a plurality of electrically conductive terminals which are embedded in the stator, said stator comprising an integrated circuit on which the magnetic field sensitive means are arranged for providing an electrical signal depending on the position of the permanent magnet and hence of the rotor.

A position sensor of the above mentioned type is disclosed in US-A-4,415.856. This prior art sensor has its rotor mounted through an aperture in a panel of a housing. The stator integrated circuit placed in a dual-in-line package (DIP) is mounted on a printed circuit board in the housing below the rotor. Such DIP member is a standard component having a size of approx. 10 x 6 mm with a distance between its four terminals on each side of approx. 2,5 mm. The mutually independent mounting of the stator and rotor implies a considerable distance between the magnet of the rotor and the magnetic field sensitive elements in the stator which is detrimental to a reliable and precise operation. This again, however, has the adverse effect of increasing the required size of the permanent magnet for obtaining a sufficient magnetic response of the sensitive elements. The total height of a sensor of this kind is large due to the above indicated structural features and the termination method to be used on the DIP member.

A position sensor of the above mentioned type is, through its integral circuits, particularly suitable for providing digital output signals, which is important when the remaining circuits of an equipment are entirely or partially based on such signals. However, this known Hall effect position sensor is not suitable - nor meant - for microelectronic use where the outer dimensions of a component, e.g. for use in hearing aids, should not exceed a magnitude of 3-4 mm, neither in diameter nor in height, and therefore it does not offer a solution of position sensors of such size and having sufficiently accurate operation positions. The same applies to other known embodiments of Hall effect position sensors or rotary switches, cf. e.g. US patent Nos. US-A-4054860, US-A-4054861, US-A-4199741, and US-A-4459578 and DE patent publication No. DE-A-3908892.

Electronic pulse generators for microelectronic use e.g. in hearing aids are known from the Applicant's Danish patents DK-B-168258 and DK-B-168257. Although the inventions according to these applications relate to a development of such pulse generators towards an increasingly simple and at the same time electronically more reliable electromechanical construction, they are, precisely from a construction point of view, comparatively complex with the ensuing risks of malfunction during use thereof in hearing aids, and correspondingly costly to produce.

It is therefore the object of the invention to provide a microelectronic position sensor, in particular for use in hearing aids and the like, which remedies the above disadvantages of the hitherto known position sensors or electromechanical pulse generators.

This object is achieved by means of a microelectronic position sensor of the type disclosed in the introductory part of claim 1 which is characterized by the features disclosed in the characterizing part of that claim.

Further advantageous features of the microelectronic position sensor according to the invention will appear from claims 2-10.

The microelectronic position sensor according to the invention is particularly outstanding due to its very simple construction with few mechanical parts and its surprisingly high degree of operational accuracy, all of which is obtained while retaining the very small outer dimensions, about one order of magnitude smaller than the prior art position sensor initially mentioned.

The position sensor is incorporated as a component of e.g hearing aids and the like with full digital control, that is electronic control based on a computer circuit. It is expected that hearing aids of this type will become an important object for the future further development of hearing aids in general. One of the properties of this component with respect to this use in addition to its mode of operation will be a highly improved reliability compared to the hitherto known volume controls and switches.

Therefore, the component is constructed as a simple magnetic system which contains only a magnet and an integrated circuit (IC) which is located in the magnetic field. The magnetic system may be designed in many ways. Thus, the magnet may be located parallelly with or angularly to the integrated circuit. The integrated circuit comprises a serial data line which, via a single electrical connection, transmits binary figures corresponding to 0 and 1 which, in turn, correspond to low and high voltages. The incorporation of a computer into a hearing aid permits the computer to carry out comparatively complex operations on the basis of a simple input signal via the serial data line. The position sensor provides a signal in the form of a code (a number) corresponding to the rotor position relative to the stator whereupon the computer converts the signal to the desired adjustment of the hearing aid, be it volume control, switch of program, tone control, mode shift or the like.

The rotor with the incorporated permanent rod- or disc-shaped magnet may be freely rotated manually over 360° on the stator whereby the magnet influences on the circuits of the integrated circuit in the stator so as to allow the integrated circuit to determine the instanta-

neous position of the rotor. If desired, the stator may be provided with a mechanical stop for the rotation of the rotor. The rotor and stator may conveniently be made of a moulded plastics material. The component appears with the built-in integrated circuit as an active component which requires an energy supply usually with a supply voltage higher than or equal to 1 V and having a tolerance of up to 5 V and a ripple of ± 0.3 V with a ripple frequency of less than 2000 Hz. Therefore, the component is usually provided with three terminals for this purpose which are embedded in the stator, viz. the line whereupon data from the component to the computer of the hearing aid is transmitted and the positive and negative battery voltage. The signalling could also be effected as a current or voltage modulation on the power supply line. In that case the component could be made to operate with two connections only.

It is often necessary to adjust the supply voltage in microelectronic devices. However, a control of the battery voltage may often only partially be incorporated in the integrated circuit which should therefore be supplemented with an external capacitor having its own terminal. Thus, the component has a further terminal, i.e. normally a total of four terminals which are electrically conductively connected to the integrated circuit.

Following mounting of the terminals on the integrated circuit, the latter may be embedded into the stator.

The integrated circuit also comprises a number of magnetic field sensitive elements consisting of a magnetic field effect transistor (MAGFET) having two or more drains for splitting the current in the individual MAGFET, such splitting permitting measurement of the differential current between the terminals of the elements when, by means of the permanent magnet of the rotor, a magnetic field is established perpendicular to the element. Measurement of the differential current presents an advantage as to the noise-level of the component compared to measurement of voltage in a Hall element and, likewise, the use of e.g. three drains provides an improved sensitivity.

The determination of the rotor position relative to that of the stator by means of the integrated circuit is effected either digitally or analogly.

In the digital solution, the magnetic field sensitive elements or sensors in the integrated circuit are arranged on a circle and in a number corresponding to the desired angular resolution whereupon the signals from the individual sensors are compared by means of a number of comparators so as to generate a series of digital signals from the comparisons which, by use of a digital decoding circuit, are converted to digital codes. The inconvenience associated with the digital solution is the positioning of many sensors, e.g. 64, with corresponding connections to obtain a desired angular resolution, on a circle in the integrated circuit. The advantage associated with the digital solution consists in fast and simple measurements with the exclusive use of comparators.

In the analog solution, the magnitude of the magnetic field is measured with one or more sensors which provide(s) an analog signal depending on the position of the permanent magnet and which may consequently be used for the position determination.

A sensor provides a signal which is approximately linearly depending on the relevant applied magnetic field. The magnetic field varies with the rotor position and if there is to be proportionality betweeen the signal and the rotational angle, the magnetic field should vary linearly with the angle.

With only one sensor it is impossible to obtain an unambiguous relation between signal and position. When the rotor and thus the magnet is rotated 360°, the field will vary from a minimum value to a maximum and back again. Therefore, the same field strength will occur for two positions of the rotor. The lacking information about the position is obtained by means of an additional sensor which senses the field at a certain distance from the first one.

If the field varies sinusoidally, two sensors may advantageously be applied which are displaced 90° relative to each other and then the sensor is used which, for a given position, provides the most convenient signal. According to the circumstances, the sensor which provides the most powerful signal is used and which thus reduces the noise problems, or else the sensor which provides the smallest signal and which consequently has the highest sensitivity = largest change of the signal for a small position change (the sensor with the largest signal provides less sensitivity, the field being here on the flat top at a maximum).

The signal from the sensor is converted by an A/D converter to a digital code which may assume a possible number of values corresponding to the given number of bits in the code. This presents a problem as it is not known how large the maximum signal from the sensor will be. Variations in the magnetic circuit will occur which may give rise to variations in the maximum magnetic field strength, and differences in the parameters of the electronic circuit may occur.

This means that there is a risk that the codes corresponding to the largest signals may drop out so that maximum (or minimum) may not be set on the component.

However, there may always be used a suitably wide safety margin, so that the signal will be sufficiently large to prevent codes from dropping out. If the variations are wide, however, this margin should be sufficiently wide to form, when the signal is at its largest, a large angle range, in which the A/D converter provides a fixed maximum or minimum value.

The problem of the unknown largest and smallest values provided by the sensor may be solved by using two sensors which are displaced 90° relative to each other and by utilizing the fact that it is guaranteed that the signal can reach 0.

The sensor which provides the smallest signal is

used to provide the measurement signal. The other sensor is used as a reference, and for the position determination the value is used which is obtained by division of the measurement signal with the reference signal. If the measurement signal is 0, the reference value will be the maximum. If the angle is changed slowly the measurement signal will increase and the reference value will decrease. In total an increasing value will be obtained which will be 1 when the measurement signal and the reference signal have reached the same level. This corresponds to an angle of 45° relative to the 0 level.

The reference signal is compared to the measurement signal by means of a comparator and when the measurement signal is the largest the two signals change rôles. A rotation over an angle of 90° from the 0 level will generate a signal which varies from 0 at 0° to 1 at 45° and back to 0 at 90°. Therefore, this signal cannot be used directly. All codes will appear twice within an angle range of 90°. The lacking information is obtained from the comparator which provides one more bit to the code corresponding to the sensor which provides the largest signal and is used as reference.

In this way, the last half of the range of the 90° will yield decreasing values from the maximum code occurring at 45°. This problem is solved by digitally complementing the signal code when the comparator indicates that the signal originates in the range providing the decreasing codes. This is effected before the code is increased with the extra bit from the comparator.

This combination of two sensors provides the principle of the solution to the maximum problem. It cannot be applied in practice as it works only within 90°. However, the principle may be expanded so as to be applicable over all 360°. It requires four sensors, three additional comparators and a slightly more comprehensive digital control. The comparators compare the signals from the four sensors and select those two which provide positive signals for the measurement. The measurement by means of those two sensors is effected in the same manner as measurement with a total of only two sensors. However, the code is not increased with one bit from one comparator, but instead with three bits in accordance with the sensors selected for the measurement.

A code having 64 values corresponding to six bits means that half of the bits come from the comparators and thus only a three-bits A/D converter is needed.

Since the processing of the signals from the sensors comprises a division of two analog signals with each other, a dual-slope A/D converter is conveniently used to solve both the division and the conversion problems.

The signal (the differential current) from the measurement sensor is used for charging a capacitor in the converter for a determined period of time. Then the capacitor is discharged by the reference signal and the discharge period is used as a measure of the position.

The analog solution using the A/D converter presents the advantage that it is very simple to double the number of codes. This is done by allowing the A/D conversion to be effected with one additional bit. If it is desired to have e.g. a seven-bits code for the position, the additional bit may be introduced simply by using a four-bits A/D converter. Such doubling of the number of codes presents certain problems in the digital solution, e.g. with dimension tolerances.

An increase of the number of codes may provide an increased angular resolution, but an additional advantage associated with the additional bit is that it may be used for noise suppression. For instance, the circuit may be so designed that it does not transmit a new position code until one is detected which is a certain value higher than the preceding one or which is different from the two most recently registered positions.

According to a particular embodiment, the integrated circuit contains a potentiometer or a variable resistor in addition to the magnetic field sensitive elements and the further position determining circuits, thereby making the component appear as a conventional rotary potentiometer thus allowing use of the component in conventional microelectronic devices without fully digital control.

According to another particular embodiment the integrated circuit in addition to the magnetic field sensitive elements and other position determining circuits contains an amplifier with variable amplification for amplifying electronic signals. The amplification is determined by the position of the rotor relative to the stator.

Finally, the integrated circuit may comprise a control circuit for supply voltage so that external control thereof is unnecessary.

The invention will now be described in further detail with reference to the drawings which in a non-limiting manner exemplify an embodiment of the invention, and wherein

Fig. 1 is a vertical section through a position sensor and

Fig. 2 is an exploded view thereof.

1 denotes a circular rotatable knob or rotor having a downwardly facing hollow space 8 wherein a permanent magnet 2 - in the figure a rod magnet - is arranged. In its mounted position, the rotor 1 engages in a known manner and by means of an inwardly facing flange 9 with a corresponding outwardly facing flange 10 on a base portion or stator 3, in the internal upwardly facing hollow space 11 of which a soft-iron disc 5 is mounted and immediately on top of the disc an integrated circuit 4 having magnetic field sensitive elements is mounted. To peripheral areas of the circuit, a total of four terminals 6 are mounted by tape automated bonding (TAB) and thus in electrically conductive connection thereto, said terminals 6 being embedded in the hollow space 11 of the stator 3 together with the circuit 4 and the iron disc. The terminals 6 are embedded in the stator or they ex-

tend through its wall through ducts or notches 7.

When the rotor 1 with the magnet 2 is rotated relative to the stator 3 with the integrated circuit 4, which rotation may be effected freely in both directions over 360°C, the position change of the magnet effected is sensed by the magnetic field sensitive elements of the circuit and is converted as disclosed above to a digital code which is transmitted to a computer in a not shown hearing aid of which the position sensor is a part. The computer converts the code signal received to the desired function in the apparatus, e.g. to increase or reduce the volume.

Claims

1. A microelectronic position sensor, e.g. for use in hearing aids and the like for volume control, function shifts or changes of another adjustable parameter of the apparatus, said position sensor operating by means of magnetic field sensitive elements and comprising a stationary base portion or stator (3) which contains magnetic field sensitive elements and an adjustment means or rotor (1) which is rotatably mounted and contains a permanent magnet (2), and wherein the stator (3) is electrically coupled to the apparatus by means of a plurality of electrically conductive terminals (6) which are embedded in the stator (3), said stator (3) comprising an integrated circuit (4) on which the magnetic field sensitive means are arranged for providing an electrical signal depending on the position of the permanent magnet and hence of the rotor, **characterized** in that the stator (3) and rotor (1) comprise housing parts having interengaging flanges (10,9) and forming together a self-contained unit encompassing the electric and magnetic components of the sensor and in which the rotor is rotatably mounted on the stator, that a soft-iron member (5) is arranged in the stator (3) so as to form an iron return path in the magnetic system comprising the permanent magnet and the magnetic field sensitive elements, and that the electrically conductive contact between the terminals (6) and the integrated circuit (4) is effected by "Tape Automated Bonding" to the integrated circuit (4), each terminal (6) being separately secured to the integrated circuit.

2. A microelectronic position sensor according to claim 1, **characterized** in that the magnet (2) built into the rotor (1) is in the shape of a rod, an elliptic disc or a circular disc to obtain an optimum field variation in the position determining circuit.

3. A microelectronic position sensor according to any one of the preceding claims, **characterized** in that the stator (3) is provided with a mechanical stop for the rotation of the rotor (1).

4. A microelectronic position sensor according to claim 1, **characterized** in that the integrated circuit (4) comprises at least one magnetic field effect transistor (MAGFET) having two or more drains for splitting the current in the circuit.

5. A microelectronic position sensor according to claim 1, **characterized** in that the integrated circuit (4) contains a plurality of circularly positioned magnetic field sensitive elements and a plurality of comparators for comparing the signals from the individual elements to each other so as to produce a series of digital signals which are converted to digital codes.

6. A microelectronic position sensor according to claim 1, **characterized** in that the circuit (4) contains at least two magnetic field sensitive elements which are mutually displaced relative to each other, and at least one comparator and an A/D converter which analogously measure the relation between the signals from two mutually displaced elements and converts the signal measured to a digital code.

7. A microelectronic position sensor according to claim 6, **characterized** in that a dual-slope A/D converter is used to calculate the relation between the signals from the two mutually displaced magnetic field sensitive elements.

8. A microelectronic position sensor according to claim 1, **characterized** in that the circuit (4) comprises a serial data line in the form of an electrical connection via which binary digits corresponding to 0 and 1 are transmitted, said digits, in turn, corresponding to low and high voltages, respectively, or vice versa.

9. A microelectronic position sensor according to claim 1, **characterized** in that the integrated circuit (4) comprises a potentiometer or a variable resistor thereby making the position sensor appear as a rotary potentiometer.

10. A microelectronic position sensor according to claim 1, **characterized** in that the integrated circuit (4) comprises an amplifier with variable amplification so as to determine the amplification therein by the position of the rotor (1) relative to the stator (3).

Patentansprüche

1. Mikroelektronischer Positionssensor, z.B. zur Verwendung in Hörhilfen und dergleichen zur Lautstärkeregelung, Funktionsumstellungen und Änderungen anderer einstellbarer Parameter des Gerätes, wobei der Positionssensor mittels Magnetfeldemp-

findlichkeitselementen arbeitet und einen stationären Basisabschnitt oder Stator (3) aufweist, der Magnetfeldempfindlichkeitselemente und eine Einstellvorrichtung oder einen Rotor (1) enthält, der drehbar angebracht ist und einen Permanentmagneten (2) enthält, und bei dem der Stator (3) mittels einer Vielzahl von elektrisch leitenden Anschlüssen (6), die in den Stator (3) eingebettet sind, elektrisch an das Gerät angeschlossen ist, wobei der Stator (3) einen integrierten Schaltkreis (4) aufweist, auf dem die Magnetfeldempfindlichkeitsvorrichtungen angebracht sind, um ein elektrisches Signal zu liefern, das von der Position des Permanentmagneten und somit des Rotors abhängt, dadurch gekennzeichnet, daß der Stator (3) und Rotor (1) Gehäuseteile aufweisen, die ineinander eingreifende Flansche (10,9) haben und zusammen eine selbstenthaltene Einheit bilden, die die elektrischen und magnetischen Komponenten des Sensors enthält, und in der der Rotor drehbar auf dem Stator angebracht ist, und daß ein Weicheisen-Element (5) in dem Stator (3) angeordnet ist, um einen Eisenrückweg in dem Magnetsystem mit dem Permanentmagneten und den Magnetfeldempfindlichkeitselementen zu bilden, und daß der elektrisch leitende Kontakt zwischen den Anschlüssen (6) und dem integrierten Schaltkreis (4) durch Tape Automated Bonding an den integrierten Schaltkreis (4) durchgeführt wird, wobei jeder Anschluß (6) getrennt an den integrierten Schaltkreis gesichert ist.

2. Mikroelektronischer Positionssensor gemäß Anspruch 1, dadurch gekennzeichnet, daß der in den Rotor (1) eingebaute Magnet (2) die Form eines Stabes, einer elliptischen Scheibe oder einer kreisförmigen Scheibe hat, um eine optimale Feldänderung in der positionsbestimmenden Schaltung zu erhalten.

3. Mikroelektronischer Positionssensor gemäß irgendeinem der vorherigen Ansprüche, dadurch gekennzeichnet, daß der Stator (3) mit einer mechanischen Stoppvorrichtung für die Drehung des Rotors (1) ausgestattet ist.

4. Mikroelektronischer Positionssensor gemäß Anspruch 1, dadurch gekennzeichnet, daß der integrierte Schaltkreis (4) zumindest einen Magnetfeldeffekttransistor (MAGFET) aufweist, der zwei oder mehr Kanäle zum Aufteilen des Stromes in dem Schaltkreis hat.

5. Mikroelektronischer Positionssensor gemäß Anspruch 1, dadurch gekennzeichnet, daß der integrierte Schaltkreis (4) eine Vielzahl von kreisförmig positionierten Magnetfeldempfindlichkeitselementen und eine Vielzahl von Vergleichern zum Vergleichen der Signale von den einzelnen Elementen miteinander aufweist, um eine Reihe von digitalen Signalen zu erzeugen, die in digitale Codes umgewandelt werden.

6. Mikroelektronischer Positionssensor gemäß Anspruch 1, dadurch gekennzeichnet, daß der Schaltkreis (4) zumindest zwei Magnetfeldempfindlichkeitselemente, die zueinander versetzt angeordnet sind, und zumindest einen Vergleicher und einen Analog-Digital-Umwandler enthält, die analog das Verhältnis zwischen den Signalen von zwei zueinander versetzt angeordneten Elementen messen und das gemessene Signal in einen digitalen Code umwandeln.

7. Mikroelektronischer Positionssensor gemäß Anspruch 6, dadurch gekennzeichnet, daß ein Dual-Slope-Analog-Digital-Umwandler verwendet wird, um das Verhältnis zwischen den Signalen von den zwei zueinander versetzt angeordneten Magnetfeldempfindlichkeitselementen zu berechnen.

8. Mikroelektronischer Positionssensor gemäß Anspruch 1, dadurch gekennzeichnet, daß der Schaltkreis (4) eine Serien-Datenleitung in der Form einer elektrischen Verbindung aufweist, über die binäre Zahlen entsprechend 0 und 1 übertragen werden, wobei die Zahlen wiederum jeweils niedrigen und hohen Spannungen oder umgekehrt entsprechen.

9. Mikroelektronischer Positionssensor gemäß Anspruch 1, dadurch gekennzeichnet, daß der integrierte Schaltkreis (4) ein Potentiometer oder einen variablen Resistor aufweist, wodurch der Positionssensor als ein Drehpotentiometer erscheint.

10. Mikroelektronischer Positionssensor gemäß Anspruch 1, dadurch gekennzeichnet, daß der integrierte Schaltkreis (4) einen Verstärker mit variabler Verstärkung aufweist, um die Verstärkung darin durch die Position des Rotors (1) bezüglich des Stators (3) zu bestimmen.

Revendications

1. Capteur microélectronique de position, par exemple destiné à être utilisé dans les appareils d'assistance auditive et analogues pour le réglage de volume, un changement de fonction ou d'autres modifications d'un autre paramètre réglable de l'appareil, le capteur de position travaillant à l'aide d'éléments sensibles à un champ magnétique et comprenant un stator ou partie fixe de base (3) qui contient des éléments sensibles à un champ magnétique et un dispositif d'ajustement ou rotor (1) qui est monté afin qu'il puisse tourner et qui contient un aimant permanent (2), et dans lequel le stator (3)

est couplé électriquement à l'appareil par plusieurs bornes (6) conductrices de l'électricité qui sont enrobées dans le stator (3), le stator (3) comprenant un circuit intégré (4) sur lequel est placé le dispositif sensible au champ magnétique afin qu'il donne un signal électrique et qui dépend de la position de l'aimant permanent et donc du rotor, caractérisé en ce que le stator (3) et le rotor (1) comportent des parties de boîtier ayant des flasques coopérants (10, 9) et formant ensemble une unité autonome entourant les éléments électriques et magnétiques du capteur, et dans lequel le rotor est monté afin qu'il puisse tourner sur le stator, en ce qu'un organe (5) de fer doux est placé dans le stator (3) afin qu'il forme un trajet de retour de fer dans le système magnétique comprenant l'aimant permanent et les éléments sensibles au champ magnétique, et en ce que le contact conducteur de l'électricité entre les bornes (6) et le circuit intégré (4) est réalisé par une "liaison automatique par bande" au circuit intégré (4), chaque borne (6) étant fixée séparément au circuit intégré.

2. Capteur microélectronique de position selon la revendication 1, caractérisé en ce que l'aimant (2) incorporé au rotor (1) a la forme d'une tige, d'un disque elliptique ou d'un disque circulaire donnant une variation optimale du champ dans le circuit de détermination de position.

3. Capteur microélectronique de position selon l'une quelconque des revendications précédentes, caractérisé en ce que le stator (3) possède un organe mécanique d'arrêt de la rotation du rotor (1).

4. Capteur microélectronique de position selon la revendication 1, caractérisé en ce que le circuit intégré (4) comporte au moins un transistor à effet de champ magnétique (MAGFET) ayant au moins deux drains destinés à diviser le courant dans le circuit.

5. Capteur microélectronique de position selon la revendication 1, caractérisé en ce que le circuit intégré (4) contient plusieurs éléments sensibles au champ magnétique et placés en cercle, et plusieurs comparateurs qui comparent les signaux des éléments individuels les uns aux autres afin qu'ils donnent une série de signaux numériques qui sont transformés en codes numériques.

6. Capteur microélectronique de position selon la revendication 1, caractérisé en ce que le circuit (4) contient au moins deux éléments sensibles au champ magnétique qui sont décalés mutuellement l'un par rapport à l'autre, et au moins un comparateur et un convertisseur analogique-numérique qui mesurent analogiquement la relation entre les signaux des deux éléments décalés mutuellement et transforment le signal mesuré en un code numérique.

7. Capteur microélectronique de position selon la revendication 6, caractérisé en ce qu'un convertisseur analogique-numérique à double pente est utilisé pour le calcul de la relation entre les signaux provenant des deux éléments sensibles au champ magnétique qui sont décalés l'un par rapport à l'autre.

8. Capteur microélectronique de position selon la revendication 1, caractérisé en ce que le circuit (4) possède une ligne de données en série sous forme d'une connexion électrique par l'intermédiaire de laquelle des chiffres binaires correspondant à O et 1 sont transmis, ces chiffres correspondant à leur tour a des tensions faible et élevée respectivement ou inversement.

9. Capteur microélectronique de position selon la revendication 1, caractérisé en ce que le circuit intégré (4) possède un potentiomètre et une résistance variable, de manière que le capteur de position paraisse former un potentiomètre rotatif.

10. Capteur microélectronique de position selon la revendication 1, caractérisé en ce que le circuit intégré (4) possède un amplificateur à amplification variable destiné à déterminer l'amplification par la position du rotor (1) par rapport au stator (3).

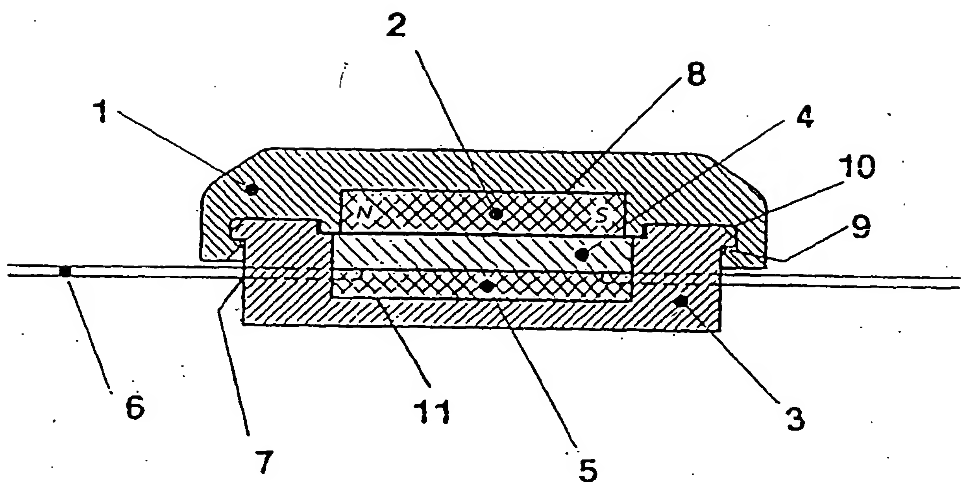

Fig. 1

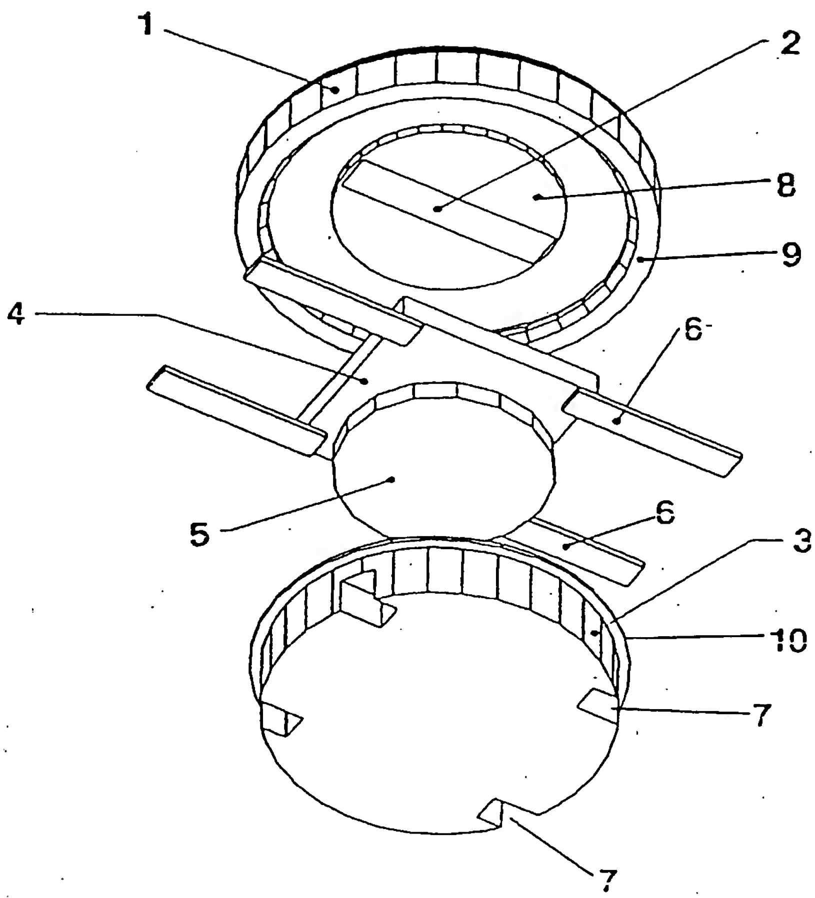

Fig 2